FIG. 1

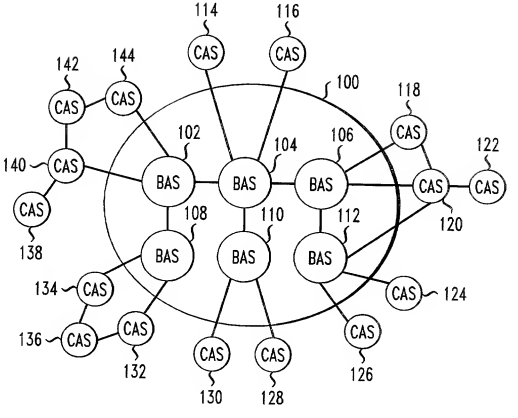

114
116
CAS
CAS
142
144
CAS
CAS
100
118
CAS
102
104
106
122
140
CAS
BAS
BAS
BAS
CAS
CAS
CAS
120
108
110
112
138
BAS
BAS
BAS
134
CAS
CAS
124
136
CAS
CAS
CAS
132
CAS
CAS
126
130
128

FIG. 2

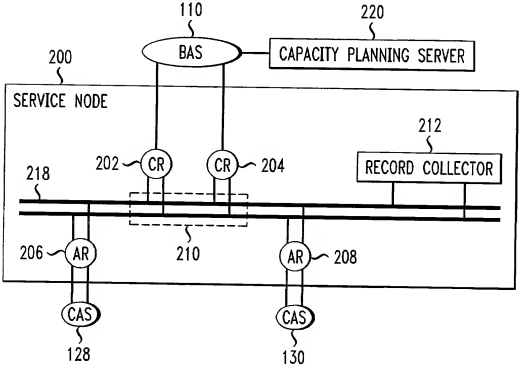

110
220
200
BAS
CAPACITY PLANNING SERVER
SERVICE NODE
212
202
CR
CR
204
RECORD COLLECTOR
218
206
AR
210
AR
208
CAS
CAS
128
130

FIG. 3

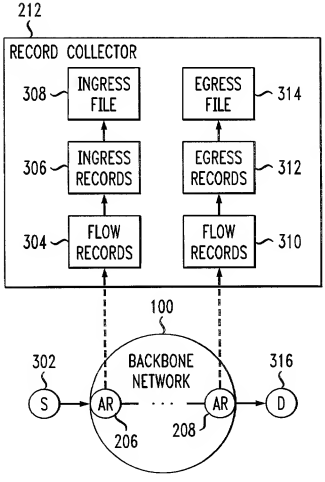

212
RECORD COLLECTOR
308
INGRESS FILE
314
EGRESS FILE
306
INGRESS RECORDS
312
EGRESS RECORDS
304
FLOW RECORDS
310
FLOW RECORDS
100
302
BACKBONE NETWORK
316
S
AR
AR
D
206
208

FIG. 4

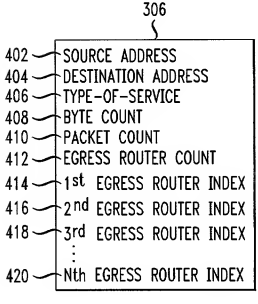

306
402 SOURCE ADDRESS
404 DESTINATION ADDRESS
406 TYPE-OF-SERVICE
408 BYTE COUNT
410 PACKET COUNT
412 EGRESS ROUTER COUNT
414 1st EGRESS ROUTER INDEX
416 2nd EGRESS ROUTER INDEX
418 3rd EGRESS ROUTER INDEX
420 Nth EGRESS ROUTER INDEX

FIG. 5

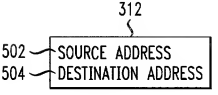
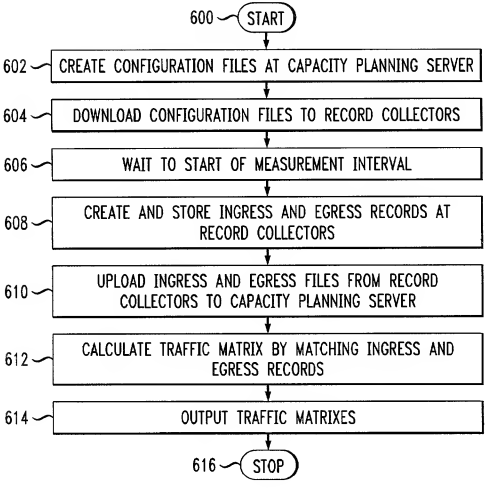

312
502
SOURCE ADDRESS
504
DESTINATION ADDRESS

FIG. 6


600
START
602
CREATE CONFIGURATION FILES AT CAPACITY PLANNING SERVER
604
DOWNLOAD CONFIGURATION FILES TO RECORD COLLECTORS
606
WAIT TO START OF MEASUREMENT INTERVAL
608
CREATE AND STORE INGRESS AND EGRESS RECORDS AT RECORD COLLECTORS
610
UPLOAD INGRESS AND EGRESS FILES FROM RECORD COLLECTORS TO CAPACITY PLANNING SERVER
612
CALCULATE TRAFFIC MATRIX BY MATCHING INGRESS AND EGRESS RECORDS
614
OUTPUT TRAFFIC MATRIXES
616
STOP

Sent by: Cooper

FIG. 7

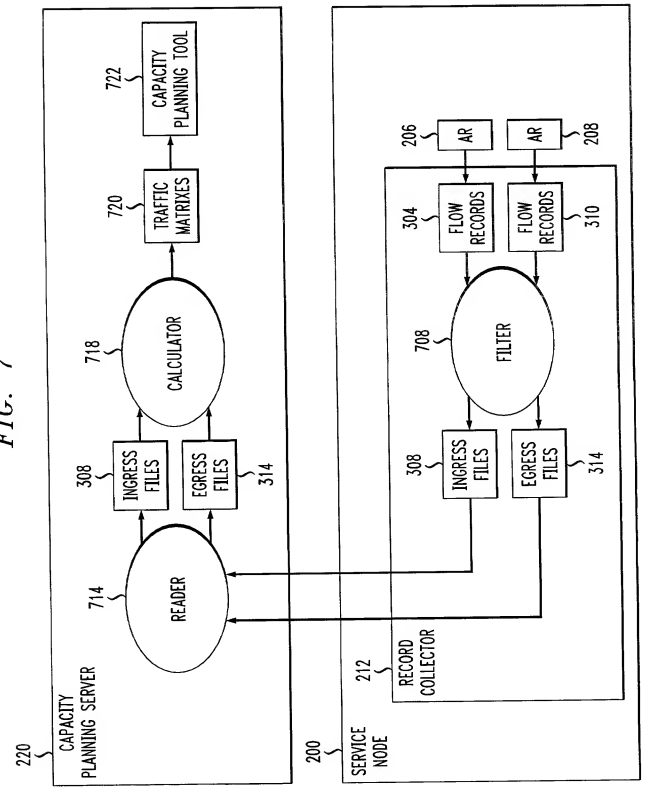


FIG. 8A

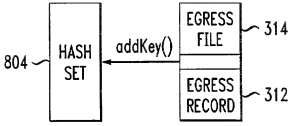

804
HASH SET
addKey()
EGRESS FILE
314
EGRESS RECORD
312

FIG. 8B

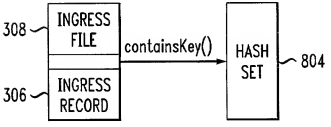

308
INGRESS FILE
306
INGRESS RECORD
containsKey()
HASH SET
804

FIG. 9A

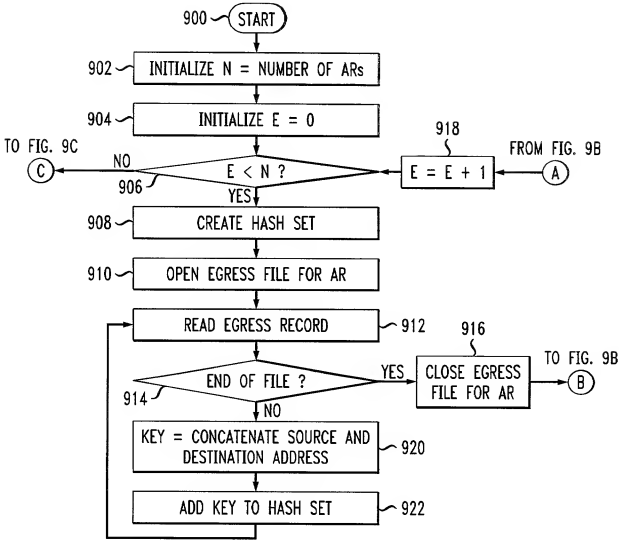

900
START
902
INITIALIZE N = NUMBER OF ARs
904
INITIALIZE E = 0
TO FIG. 9C
C
NO
906
E < N ?
YES
908
CREATE HASH SET
910
OPEN EGRESS FILE FOR AR
READ EGRESS RECORD
912
914
END OF FILE ?
YES
916
CLOSE EGRESS FILE FOR AR
TO FIG. 9B
B
NO
KEY = CONCATENATE SOURCE AND DESTINATION ADDRESS
920
ADD KEY TO HASH SET
922
918
E = E + 1
FROM FIG. 9B
A

FIG. 9B

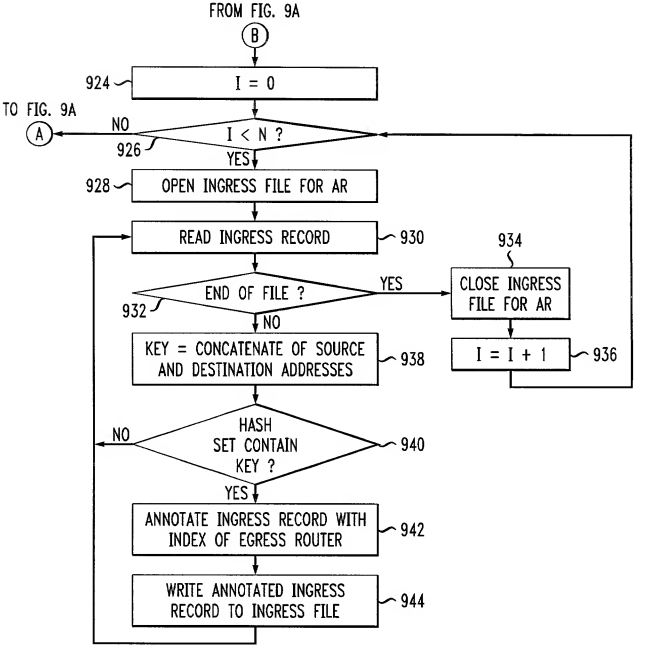

FROM FIG. 9A
B
924
I = 0
TO FIG. 9A
A
NO
I < N ?
926
YES
928
OPEN INGRESS FILE FOR AR
READ INGRESS RECORD
930
934
END OF FILE ?
YES
CLOSE INGRESS FILE FOR AR
932
NO
KEY = CONCATENATE OF SOURCE AND DESTINATION ADDRESSES
938
I = I + 1
936
NO
HASH SET CONTAIN KEY ?
940
YES
ANNOTATE INGRESS RECORD WITH INDEX OF EGRESS ROUTER
942
WRITE ANNOTATED INGRESS RECORD TO INGRESS FILE
944

FIG. 9C

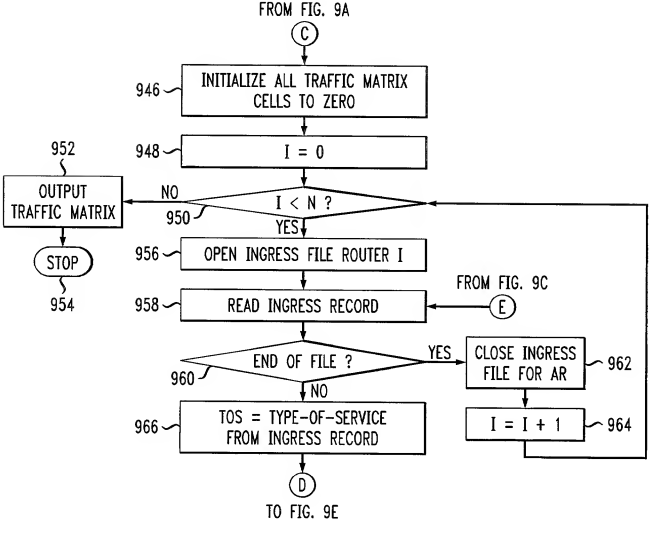

FROM FIG. 9A
C
INITIALIZE ALL TRAFFIC MATRIX CELLS TO ZERO
946
I = 0
948
I < N ?
950
NO
YES
OUTPUT TRAFFIC MATRIX
952
STOP
954
OPEN INGRESS FILE ROUTER I
956
READ INGRESS RECORD
958
FROM FIG. 9C
E
END OF FILE ?
960
YES
CLOSE INGRESS FILE FOR AR
962
NO
TOS = TYPE-OF-SERVICE FROM INGRESS RECORD
966
I = I + 1
964
D
TO FIG. 9E

FIG. 9D

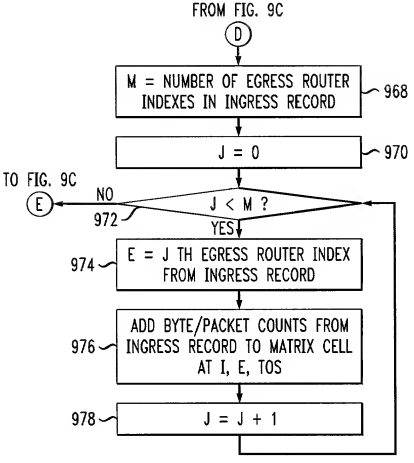

FROM FIG. 9C
D
M = NUMBER OF EGRESS ROUTER INDEXES IN INGRESS RECORD
968
J = 0
970
TO FIG. 9C
E
NO
J < M ?
972
YES
974
E = J TH EGRESS ROUTER INDEX FROM INGRESS RECORD
976
ADD BYTE/PACKET COUNTS FROM INGRESS RECORD TO MATRIX CELL AT I, E, TOS
978
J = J + 1

FIG. 10

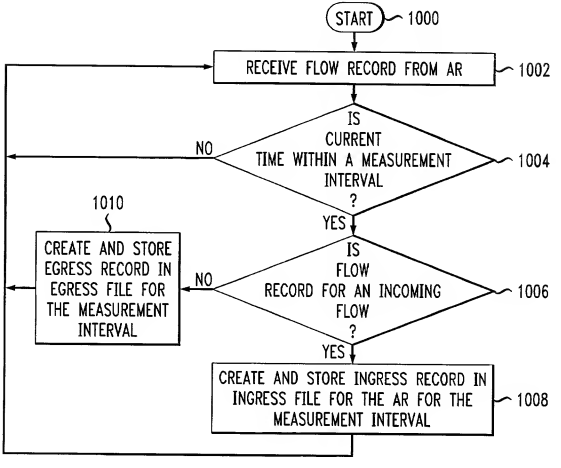

START
1000
RECEIVE FLOW RECORD FROM AR
1002
IS CURRENT TIME WITHIN A MEASUREMENT INTERVAL ?
1004
NO
YES
IS FLOW RECORD FOR AN INCOMING FLOW ?
1006
NO
YES
1010
CREATE AND STORE EGRESS RECORD IN EGRESS FILE FOR THE MEASUREMENT INTERVAL
CREATE AND STORE INGRESS RECORD IN INGRESS FILE FOR THE AR FOR THE MEASUREMENT INTERVAL
1008

FIG. 11

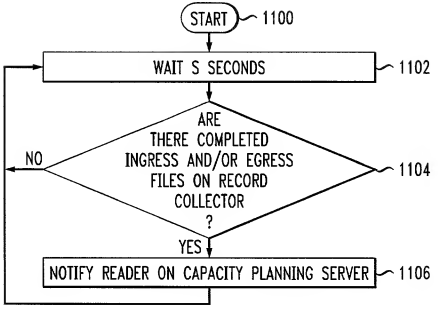

START
1100
WAIT S SECONDS
1102
ARE THERE COMPLETED INGRESS AND/OR EGRESS FILES ON RECORD COLLECTOR ?
1104
NO
YES
NOTIFY READER ON CAPACITY PLANNING SERVER
1106

FIG. 12

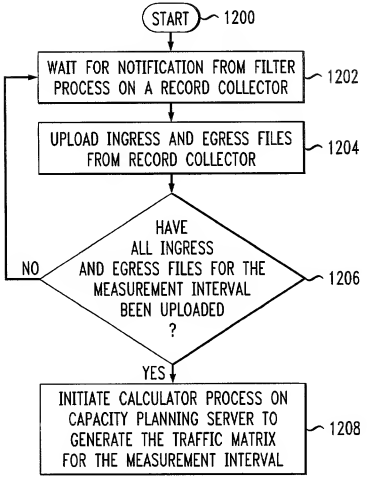

START
1200
WAIT FOR NOTIFICATION FROM FILTER PROCESS ON A RECORD COLLECTOR
1202
UPLOAD INGRESS AND EGRESS FILES FROM RECORD COLLECTOR
1204
HAVE ALL INGRESS AND EGRESS FILES FOR THE MEASUREMENT INTERVAL BEEN UPLOADED ?
1206
NO
YES
INITIATE CALCULATOR PROCESS ON CAPACITY PLANNING SERVER TO GENERATE THE TRAFFIC MATRIX FOR THE MEASUREMENT INTERVAL
1208

FIG. 13

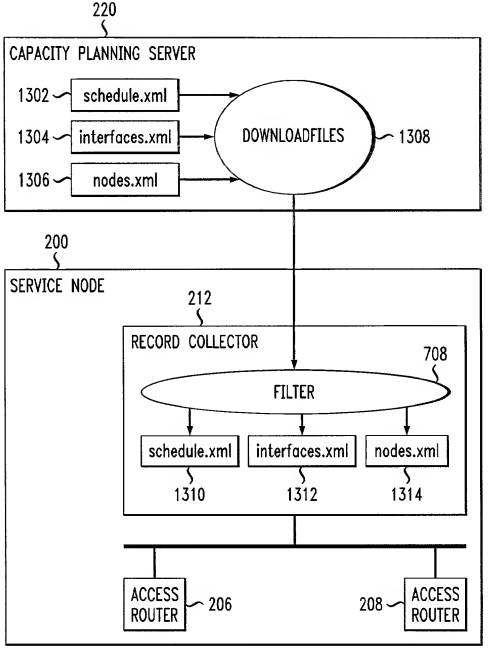

220
CAPACITY PLANNING SERVER
1302
schedule.xml
1304
interfaces.xml
1306
nodes.xml
DOWNLOADFILES
1308
200
SERVICE NODE
212
RECORD COLLECTOR
708
FILTER
schedule.xml
interfaces.xml
nodes.xml
1310
1312
1314
ACCESS ROUTER
206
208
ACCESS ROUTER

FIG. 14

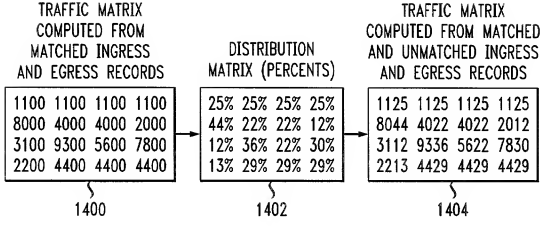


FIG. 15A

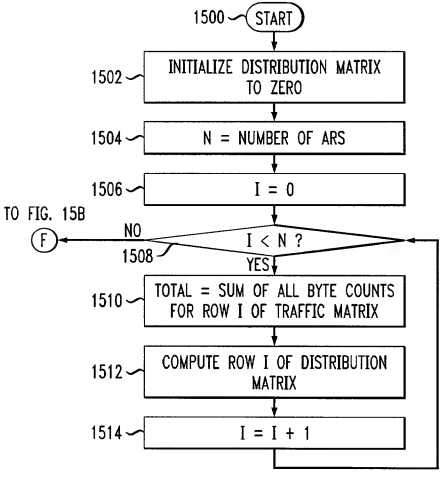


FIG. 15B

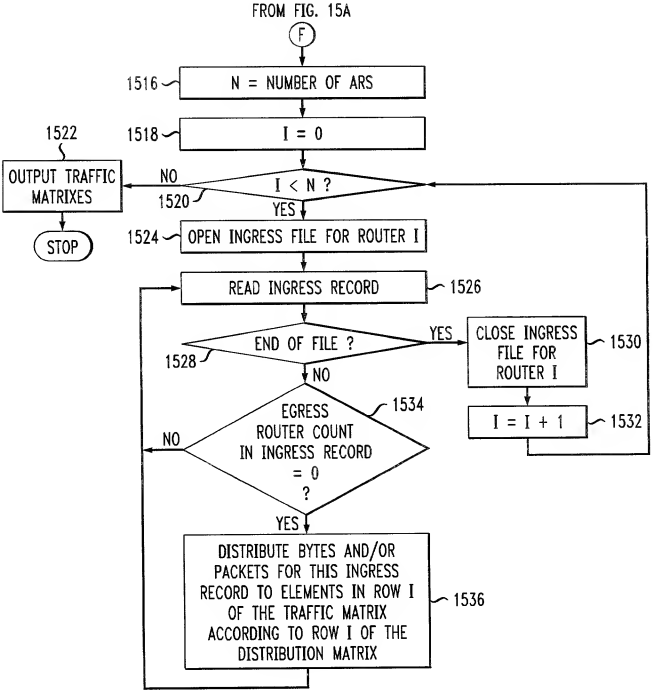

FROM FIG. 15A
F
1516
N = NUMBER OF ARS
1518
I = 0
1522
OUTPUT TRAFFIC MATRIXES
NO
I < N ?
1520
YES
STOP
1524
OPEN INGRESS FILE FOR ROUTER I
READ INGRESS RECORD
1526
END OF FILE ?
YES
CLOSE INGRESS FILE FOR ROUTER I
1530
1528
NO
EGRESS ROUTER COUNT IN INGRESS RECORD = 0 ?
1534
I = I + 1
1532
NO
YES
DISTRIBUTE BYTES AND/OR PACKETS FOR THIS INGRESS RECORD TO ELEMENTS IN ROW I OF THE TRAFFIC MATRIX ACCORDING TO ROW I OF THE DISTRIBUTION MATRIX
1536

FIG. 16

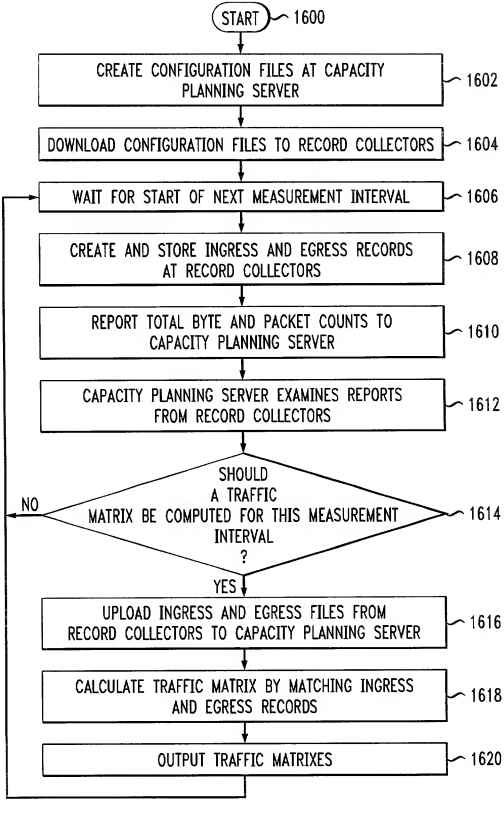

START
1600
CREATE CONFIGURATION FILES AT CAPACITY PLANNING SERVER
1602
DOWNLOAD CONFIGURATION FILES TO RECORD COLLECTORS
1604
WAIT FOR START OF NEXT MEASUREMENT INTERVAL
1606
CREATE AND STORE INGRESS AND EGRESS RECORDS AT RECORD COLLECTORS
1608
REPORT TOTAL BYTE AND PACKET COUNTS TO CAPACITY PLANNING SERVER
1610
CAPACITY PLANNING SERVER EXAMINES REPORTS FROM RECORD COLLECTORS
1612
SHOULD A TRAFFIC MATRIX BE COMPUTED FOR THIS MEASUREMENT INTERVAL ?
1614
NO
YES
UPLOAD INGRESS AND EGRESS FILES FROM RECORD COLLECTORS TO CAPACITY PLANNING SERVER
1616
CALCULATE TRAFFIC MATRIX BY MATCHING INGRESS AND EGRESS RECORDS
1618
OUTPUT TRAFFIC MATRIXES
1620

FIG. 17

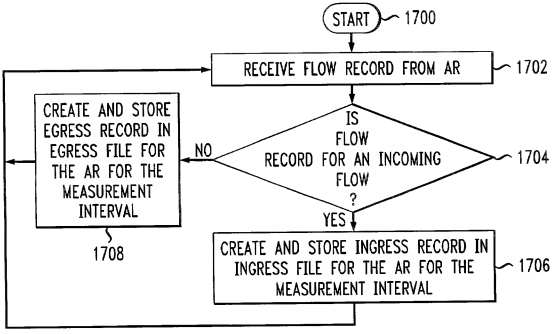

START
1700
RECEIVE FLOW RECORD FROM AR
1702
IS FLOW RECORD FOR AN INCOMING FLOW ?
1704
NO
YES
CREATE AND STORE EGRESS RECORD IN EGRESS FILE FOR THE AR FOR THE MEASUREMENT INTERVAL
1708
CREATE AND STORE INGRESS RECORD IN INGRESS FILE FOR THE AR FOR THE MEASUREMENT INTERVAL
1706

FIG. 18

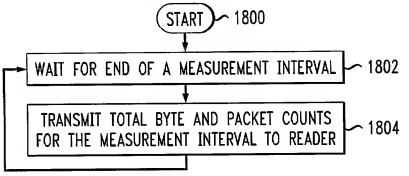

START
1800
WAIT FOR END OF A MEASUREMENT INTERVAL
1802
TRANSMIT TOTAL BYTE AND PACKET COUNTS FOR THE MEASUREMENT INTERVAL TO READER
1804

FIG. 19

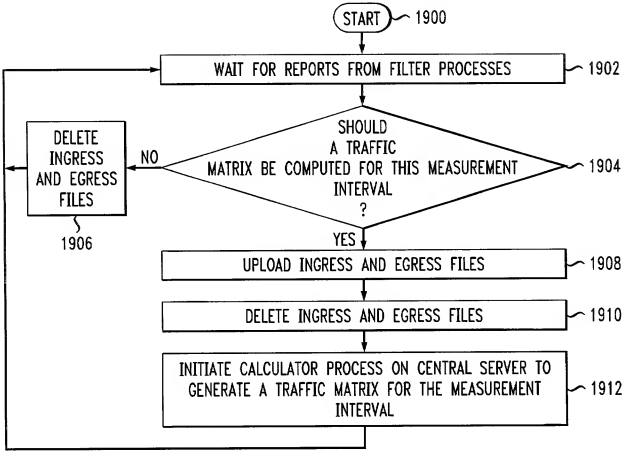

START
1900
WAIT FOR REPORTS FROM FILTER PROCESSES
1902
SHOULD A TRAFFIC MATRIX BE COMPUTED FOR THIS MEASUREMENT INTERVAL ?
1904
NO
DELETE INGRESS AND EGRESS FILES
1906
YES
UPLOAD INGRESS AND EGRESS FILES
1908
DELETE INGRESS AND EGRESS FILES
1910
INITIATE CALCULATOR PROCESS ON CENTRAL SERVER TO GENERATE A TRAFFIC MATRIX FOR THE MEASUREMENT INTERVAL
1912

FIG. 20

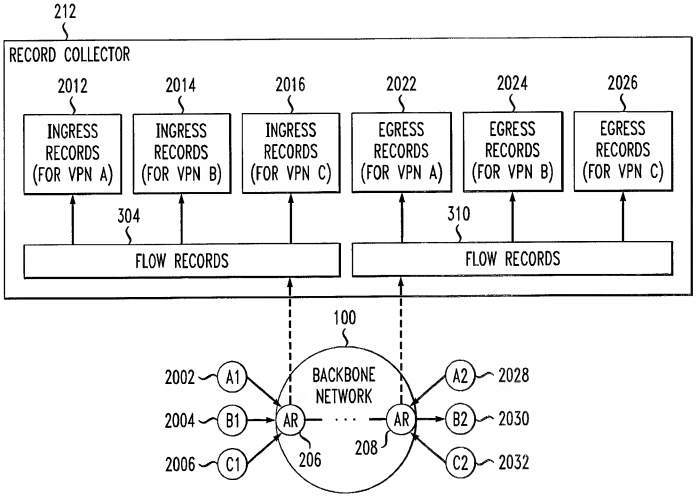
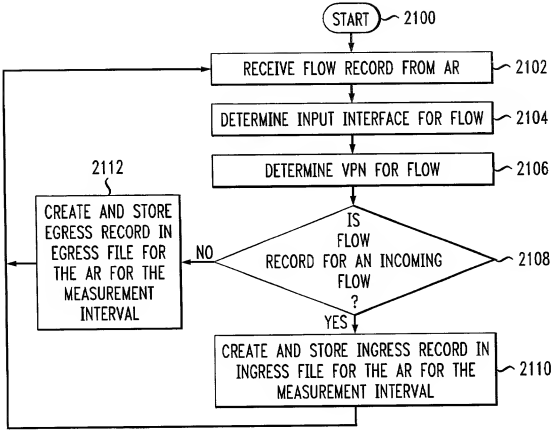

212
RECORD COLLECTOR
2012
2014
2016
2022
2024
2026
INGRESS RECORDS (FOR VPN A)
INGRESS RECORDS (FOR VPN B)
INGRESS RECORDS (FOR VPN C)
EGRESS RECORDS (FOR VPN A)
EGRESS RECORDS (FOR VPN B)
EGRESS RECORDS (FOR VPN C)
304
310
FLOW RECORDS
FLOW RECORDS
100
BACKBONE NETWORK
2002
A1
2004
B1
2006
C1
AR
AR
206
208
A2
2028
B2
2030
C2
2032

FIG. 21


START
2100
RECEIVE FLOW RECORD FROM AR
2102
DETERMINE INPUT INTERFACE FOR FLOW
2104
DETERMINE VPN FOR FLOW
2106
IS FLOW RECORD FOR AN INCOMING FLOW ?
2108
NO
YES
2112
CREATE AND STORE EGRESS RECORD IN EGRESS FILE FOR THE AR FOR THE MEASUREMENT INTERVAL
CREATE AND STORE INGRESS RECORD IN INGRESS FILE FOR THE AR FOR THE MEASUREMENT INTERVAL
2110